

Estimation of Genetic Variability and Heritability in Bread Wheat under Abiotic Stress

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ABSTRACT

An experiment was conducted to evaluate 10 diverse parents and their 45 F_1 's of bread wheat for yielding and physiological characters during season of Rabi 2014-15. Analyses of variance in 55 (45 F_1 's with their 10 parents) bread wheat genotypes for eighteen characters were showed highly significant differences indicate the presence of extensive amount of genetic variability. On the basis of mean performance, high yield per plant was observed for DBW 14 x K0424 followed by K 9162 x K 9423. Cross K 0607 x K 0911 exhibited maximum protein content in grain. The estimate of PCV and GCV were high for canopy temperature depression ($^{\circ}$ C) and for grain yield per plant, respectively. The high heritability was observed for protein content whereas grain yield per plant showed high genetic advance. Accordingly results, effective genotypes based on either mean performance and high heritability coupled with high genetic advance for interesting traits can be used further improvement of yield and its related traits through ideal breeding scheme.

Key words: Genetic variability, heritability and wheat hybrid

INTRODUCTION

Wheat is an important cereal crop after rice and which is grown about 29 million hectare acreage of across the country⁵. Wheat is consumed in a variety of ways such as bread, chapatti, porridge, flour, suji etc. It has relatively high content of niacin and thiamin which are principally concerned in providing the special protein called 'Glutin'. Currently, wheat is yield fluctuates widely as a result of

its interaction with environment because grain yield in wheat is a polygenic inherited character and is the product of several attributing factors affecting yield directly or indirectly^{1,5}. Environmental factors like heat or hot temperature play a key role for decline the production of wheat. High temperature effect, the grain quality and grain weight along with its nutritional value.

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For genetic manipulation of quality as well as grain yield with other characters in cereals, there is a need to examine the nature of genetic variability for the quality constituents and yield related attributes through hybridization. Because, estimation of GCV and PCV helps to choose the potential genotype and heritability along with genetic advance would be more useful tool in predicting the resultant effect for selection of best genotypes for yield of some of its component Kumar *et al*⁴. In the light of above, the present investigation was carried out with the aim to estimation of genetic variability and heritability in bread wheat hybrids under abiotic stress.

MATERIALS AND METHODS

Field experiment was conducted during the season of *Rabi* 2014-15 at Crop Research Farm, Nawabganj of C.S. Azad University of Agriculture and Technology, Kanpur, India. The materials in the present investigation included 45 F₁s and their ten genetically diverse parents. 45 F₁s were developed by using of 10 diallel mating design (excluding reciprocals) during *Rabi* 2013-14 at same research farm of the university. The trial was assigned in randomized block design with 3 replications; row length was 4 meter in the year of 2014-15. The spacing kept 20 cm for row to row and 5 cm for plant to plant in the experiment. Observations were recorded on grain yield, days to 75 % flowering, days to maturity, duration of reproductive phase, plant height (cm), number of effective tillers per plant, number of spikelets per spike, number of grains per spike, grain weight per spike (g), spike length (cm), biological yield per plant (g), harvest index (%), 1000 seed weight (g), spike density, canopy temperature depression (CTD) (⁰c), chlorophyll intensity (%), chlorophyll fluorescence (Fv/Fm) and protein content (%).

RESULTS AND DISCUSSION

Variability of any crop is pre-requisite for selection of superior genotype over the stress environment. Analysis of variances of 55

bread wheat genotypes is represented in Table 1. The analysis of variance for the design of experiment (RBD) involving 55 wheat genotypes evaluated for 18th characters namely, grain yield, days to 75 % flowering, days to maturity, duration of reproductive phase, plant height (cm), number of effective tillers per plant, number of spikelets per spike, number of grains per spike, grain weight per spike (g), spike length (cm), biological yield per plant (g), harvest index (%), 1000 seed weight (g), spike density, canopy temperature depression (CTD) (⁰c), chlorophyll intensity (%), chlorophyll fluorescence (Fv/Fm) and protein content (%) given in Table 1. The mean squares due to replication showed high significant for days to maturity and significant for 1000 grain weight indicate the heterogeneity present in field whereas, mean sum of square due to treatment showed high significant for all traits indicate ample scope of genotype under selection.

The mean performance of genotypes presented in Table 2. The study revealed in case of days to 75% flowering ranged from 63.33 to 90.33 days with grand mean of 77.99 days. Cross NW 2036 x K 9423 showed earliest flowered genotype followed by K 0424 x K 0911. Among the genotypes, range of days to maturity varied from 102.33 to 136.00 days. Early matured genotypes were K 0911 x NW 2036 followed by K 0424 x K 9423 and NW 2036 x K 9423. These genotypes may be use further in breeding program to obtain of early maturing genotypes. The grand mean of duration of reproductive phase was 39.7879 days with ranged of 30.00 to 47.33 days. K 1114 x K 0424 showed minimum duration of reproductive phase followed by K 0911 x K 9423 and K 0607. The range of plant height varied from 77.03 to 107.86 cm whereas grand mean of plant height was 89.63 cm. The highest plant height was observed in K 1114 x K 0911 (107.86 cm) and K 0911 x K 0307 (106.46 cm). These genotypes may be use either against hot region and development of new tall wheat lines for normal condition. Dwarfism wheat genotypes were K 0424 x K

0911 (77.03 cm) and K 0424 x K 9423 (77.40 cm). More number of effective tillers per plant was observed in K 1114 x K 0911(8.00) and K 1114 x K 0424 genotypes had maximum number of spikelets per spike. The range for effective tillers per plant and spikelets per spike varied from 3.33 to 8.00 and 15.73 to 22.46, respectively. The range of promising genotypes varied from 38.93 to 66.73 for maximum grains per spike. Out of 55, K 1114 x K 0607 (66.73) had maximum number of grains per spike. The range of grain weight per spike varied from 1.30 to 2.92 g with 2.14 g grand mean. K 0307 x K 9423 had maximum grain weight per spike. The maximum length of spike found in K 0307 (13.50). Biological yield per plant ranged from 15.65 to 31.81 g with 22.94 g grand mean. DBW 14 x K 0424 and K 0911 x K 0307 had maximum biological yield per plant under late condition. Maximum harvest index indicated that genotype produced high economic yield. The range of harvest index varied from 24.99 to 56.74 and grand mean was 46.95. Maximum harvest index was observed for DBW 14 x K 9423. K 1114 x NW 2036 had maximum 1000 grain weight indicate seed quality. The spike density ranged from 1.39 to 1.92 with 1.68 of grand mean. DBW 14 x NW 2036 expressed maximum spike density. Canopy temperature depression ($^{\circ}\text{C}$) was ranged from 1.53 to 5.43 with 3.14 of grand mean. K 9533 x K 0424 had maximum canopy temperature depression indicates cool metabolism activity under late sown condition. Chlorophyll intensity ranged from 33.40 to 54.13 with 44.38 of grand mean. DBW 14 x NW 2036 had maximum chlorophyll content whereas, range of chlorophyll fluorescence varied from 0.564 to 0.787. K 0307 was observed for high chlorophyll fluorescence, an indication of the fate of excitation energy in the photosynthetic apparatus, has been used as indicator for heat stress tolerance. The range of protein content varied from 10.16 to 15.06 g. K 0607 x K 0911 had maximum protein content whereas, grain yield per plant ranged from 5.71 to 17.04 g. DBW 14 x K 0424 followed by K 9533 x K

0307 had maximum grain yield per plant. The results of the present study are also in accordance with the earlier findings of Kumar *et al*³.

Variability expressed between genetic parameters possess great role in crop evolution and breeding scheme. The variation present in the experimental materials measured by genotypic and phenotypic variation and their coefficient and heritability and genetic advance. Genotypic and phenotypic variation, heritability, and genetic advance for 18th characters represented in Table 3. Genotypic and phenotypic coefficient of variations showed for almost characters under study. PCV and GCV ranged varied from 5.30 (1000 grain weight) to 25.13 (grain yield per plant) and 5.50 (1000 grain weight) to 26.11 (canopy temperature depression), respectively. Heritability (broad sense) observed high with ranged varied from 61.00 (spike density) to 98.00 (protein content) whereas, genetic advance ranged varied from 12.20 (spike density) to 64.75 (grain yield per plant). These findings are in accordance with the finding of Prasad *et al*⁷, and Yousaf *et al*⁹. High heritability with high genetic advance showed additive gene action whereas, high heritability with low genetic advance indicated non additive gene action. Based on results of heritability and genetic advance, traits expressed high heritability coupled with high genetic advance namely, grain yield per plant, canopy temperature depression and biological yield per plant may be use further crop improvement through simple breeding scheme. A trait exhibiting high heritability may not necessary give high genetic advance⁸. Johnson *et al*², have shown that high heritability with accompanied by high genetic advance to arrive at more reliable in predicting the response to selection.

The genotypes showing very high performance in desirable direction for various characters listed in Table-2 and selection based on high heritability with high genetic advance may be use to evolve suitable for further improvement of wheat crop.

Table 1: Analysis of variance for 18th characters in bread wheat

Characters	Source of variations		
	Replication	Treatment	Error
	<i>d.f</i> =2	<i>d.f</i> =54	<i>d.f</i> =108
Days to 75% flowering	0.042	154.25**	2.67
Days to maturity	19.21**	281.91**	3.77
Duration of reproductive phase	1.02	55.67**	0.99
Plant height (cm)	5.65	186.21**	5.06
No. of effective tillers per plant	0.067	2.39**	0.14
No. of spikelets per spike	0.031	6.58**	0.79
No. of grains per spike	34.19	135.60**	20.46
Grain weight per spike (g)	0.019	0.38**	0.019
Spike length (cm)	0.12	1.83**	0.039
Biological yield per plant (g)	0.54	52.18**	0.56
Harvest index (%)	0.056	100.41**	4.03
1000 grain weight (g)	1.23*	14.82**	0.36
Spike density	0.01	0.03**	0.006
CTD (⁰ C)	0.07	1.74**	0.13
Chlorophyll intensity (%)	1.30	80.43**	2.72
Chlorophyll fluorescence (Fm/Fv)	0.01	0.008**	0.0001
Protein content (%)	0.04	5.54**	0.038
Grain yield per plant (g)	0.10	22.67**	0.36

Note: * and ** indicate the significant levels at 5 per cent and 1 per cent, respectively

Table 2: Mean performance of 45F₁s along with their 10 diverse parents of bread wheat for 18th characters

Crosses	Days to 75 % flowering	Days to maturity	Duration of reproductive phase	Plant height (cm)	No. of effective tillers per plant	No. of spikelets per spike	No. of grains per spike	Grain weight per spike (g)	Spike length (cm)	Biological yield per plant (g)
K 9533 x K 9162	81.00	115.67	34.67	83.43	5.00	21.00	55.13	2.22	11.83	24.71
K 9533 x K 1114	82.33	118.33	36.00	87.80	5.33	22.00	52.57	2.12	12.67	26.97
K 9533 x DBW 14	78.67	114.00	35.33	92.87	4.27	19.67	49.23	1.92	11.13	18.49
K 9533 x K 0607	87.67	127.33	39.67	101.67	5.93	20.60	56.47	2.33	12.17	28.21
K 9533 x K 0424	74.33	110.33	36.00	88.70	4.27	15.73	50.67	1.98	11.23	20.77
K 9533 x K 0911	82.00	129.00	47.00	85.77	4.93	21.27	57.47	2.31	12.13	24.62
K 9533 x K 0307	76.67	112.33	35.67	91.13	6.00	21.00	62.60	2.69	13.03	29.23
K 9533 x NW 2036	74.67	116.67	42.00	81.27	4.20	19.93	49.13	1.88	12.13	21.78
K 9533 x K 9423	80.33	119.00	38.67	89.80	5.47	19.67	50.33	1.96	11.17	21.99
K 9162 x K 1114	78.67	117.67	39.00	103.60	4.33	17.53	45.00	1.83	10.30	20.69
K 9162 x DBW 14	82.67	125.33	42.67	82.20	4.33	17.00	45.53	1.75	11.30	18.76
K 9162 x K 0607	87.67	130.33	42.67	89.47	5.20	19.80	49.27	2.10	12.33	21.89
K 9162 x K 0424	71.67	108.67	37.00	79.90	5.20	19.80	56.27	2.24	11.80	22.65
K 9162 x K 0911	83.67	124.33	40.67	91.40	4.93	19.00	50.27	2.01	11.23	22.98
K9162 x K 0307	72.33	107.67	35.33	79.07	5.73	19.93	54.73	2.49	13.07	28.43
K 9162 x NW 2036	85.00	125.67	40.67	96.93	3.67	18.80	42.73	1.73	10.63	22.89
K 9162 x K 9423	78.00	117.00	39.00	100.07	6.27	20.73	64.60	2.86	12.23	29.80
K 1114 x DBW 14	76.33	123.67	47.33	92.30	4.33	19.53	52.53	2.09	12.03	19.59
K 1114 x K 0607	88.33	128.67	40.33	102.33	4.40	15.80	66.73	1.45	10.47	15.65

K 1114 x K 0424	72.33	102.33	30.00	88.17	5.67	22.47	38.93	2.78	12.37	28.46
K 1114 x K 0911	89.00	131.00	42.00	107.87	8.00	19.93	45.87	1.73	11.03	28.72
K 1114 x K 0307	89.00	136.00	47.00	90.47	4.60	18.80	49.20	2.01	11.20	23.76
K 1114 x NW 2036	69.00	106.00	37.00	100.70	6.80	19.27	51.47	2.36	11.20	30.10
K 1114 x K 9423	82.67	126.00	43.33	84.10	3.40	19.27	42.40	1.67	11.87	19.73
DBW 14 x K 0607	69.67	110.33	40.67	91.13	5.80	22.07	55.07	2.06	12.77	24.63
DBW 14 x K 0424	70.67	111.33	40.67	88.57	6.27	22.07	64.60	2.90	11.77	31.81
DBW 14 x K 0911	85.00	130.67	45.67	95.73	4.27	19.80	41.40	1.71	10.97	21.02
DBW 14 x K 0307	90.00	135.00	45.00	96.23	4.80	21.00	52.20	1.96	12.67	22.19
DBW 14 x NW 2036	70.67	105.67	35.00	82.77	4.33	21.00	48.07	2.00	10.90	19.33
DBW 14 x K 9423	72.33	115.67	43.33	80.77	5.27	20.33	60.53	2.24	11.73	21.08
K 0607 x K 0424	70.33	107.00	36.67	96.70	5.27	20.20	49.00	1.92	11.93	23.65
K 0607 x K 0911	90.33	136.00	45.67	94.57	5.07	22.33	65.33	2.90	12.93	30.25
K 0607 x K 0307	89.00	128.67	39.67	89.63	5.80	20.33	59.60	2.38	12.67	28.32
K 0607 x NW 2036	75.33	113.00	37.67	80.17	5.13	18.40	55.07	2.04	12.47	24.90
K 0607 x K 9423	72.00	113.33	41.33	84.07	4.80	20.33	43.87	1.88	12.37	20.73
K 0424 x K 0911	66.33	108.33	42.00	77.03	3.67	16.60	41.47	1.30	11.50	16.76
K 0424 x K 0307	72.00	115.33	43.33	78.57	4.33	19.00	54.33	2.29	11.00	22.44
K 0424 x NW 2036	67.67	107.00	39.33	81.53	3.47	19.00	48.60	2.18	11.03	17.79
K 0424 x K 9423	67.00	103.00	36.00	77.40	4.13	20.73	52.27	2.25	12.60	17.91
K 0911 x K 0307	85.67	131.00	45.33	106.47	5.67	21.00	62.93	2.72	11.80	30.57
K 0911 x NW 2036	68.33	102.67	34.33	82.10	5.53	21.67	64.33	2.43	12.53	26.11
K 0911 x K 9423	73.67	105.67	32.00	97.33	5.27	19.00	52.40	2.06	11.97	24.60
K 0307 x NW 2036	67.33	106.00	38.67	82.00	4.93	20.87	55.67	2.21	12.27	24.02
K 0307 x K 9423	83.67	129.67	46.00	99.13	5.07	20.80	65.40	2.92	12.03	27.46
NW 2036 x K 9423	63.33	104.33	41.00	88.83	4.20	18.47	50.87	2.06	11.07	18.77
K 9533	78.00	115.00	37.00	81.96	4.20	19.13	49.13	1.92	11.27	19.36
K 9162	85.00	121.00	36.00	91.66	4.93	19.80	49.90	2.02	11.77	19.60
K 1114	80.00	122.00	42.00	96.46	5.06	19.06	50.53	2.14	10.10	20.71
DBW 14	79.00	119.00	40.00	85.50	3.86	19.93	51.83	2.03	11.00	19.04
K 0607	83.00	116.00	32.00	94.30	4.20	19.53	52.60	2.23	11.73	20.22
K 0424	73.00	109.00	35.00	80.26	3.60	18.46	48.00	1.79	12.00	16.03
K 0911	82.00	126.00	43.00	85.26	4.40	19.53	53.46	2.13	11.93	19.12
K 0307	80.00	124.00	44.00	97.33	4.53	20.26	57.86	2.55	13.50	23.18
NW 2036	78.00	124.00	46.00	84.90	3.33	20.80	56.20	2.54	12.50	18.64
K 9423	75.00	107.00	32.00	90.70	4.73	19.33	48.60	1.97	10.10	20.75
Mean	77.99	117.78	39.78	89.63	4.87	19.78	52.73	2.14	11.77	22.94
C.V.	2.09	1.65	2.50	2.51	7.82	4.49	8.57	6.47	1.68	3.26
C.D. (5%)	2.64	3.14	1.61	3.64	0.61	1.43	7.32	0.22	0.32	1.21
C.D. (1%)	3.50	4.16	2.13	4.81	0.81	1.90	9.68	0.29	0.42	1.60

Table 2: continued

Crosses	Harvest index (%)	1000 grain weight (g)	Spike density	CTD ($^{\circ}$ C)	Chlorophyll intensity (%)	Chlorophyll Fluorescence (Fv/Fm)	Protein content (%)	Grain yield per plant (g)
K 9533 x K 9162	45.85	39.90	1.77	4.30	46.87	0.75	11.77	11.33
K 9533 x K 1114	41.01	40.18	1.74	4.10	51.40	0.76	12.00	11.05
K 9533 x DBW 14	46.36	39.26	1.77	3.87	50.30	0.74	10.63	8.57
K 9533 x K 0607	46.49	40.28	1.69	4.53	42.83	0.72	10.17	13.12
K 9533 x K 0424	41.64	38.28	1.39	5.43	49.23	0.73	10.27	8.64
K 9533 x K 0911	48.80	40.73	1.75	1.53	48.30	0.69	10.83	12.04
K 9533 x K 0307	54.06	43.35	1.61	3.43	51.47	0.70	10.70	15.80
K 9533 x NW 2036	37.96	39.17	1.64	2.73	43.30	0.75	10.27	8.27
K 9533 x K 9423	46.97	39.68	1.76	2.30	47.37	0.75	11.21	10.33
K 9162 x K 1114	41.31	40.33	1.71	2.53	40.33	0.68	11.37	8.55
K 9162 x DBW 14	42.20	38.90	1.50	5.17	44.40	0.71	11.33	7.92
K 9162 x K 0607	50.40	44.05	1.61	4.30	34.77	0.61	11.70	11.03
K 9162 x K 0424	52.40	40.11	1.68	3.73	33.83	0.68	11.53	11.88
K 9162 x K 0911	46.11	41.49	1.70	3.83	41.50	0.72	12.00	10.59
K9162 x K 0307	51.45	44.29	1.53	2.43	41.87	0.60	12.27	14.63
K 9162 x NW 2036	24.99	41.50	1.77	3.43	45.07	0.72	13.00	5.71
K 9162 x K 9423	55.33	43.98	1.69	2.47	45.77	0.73	11.23	16.49
K 1114 x DBW 14	45.58	40.26	1.62	2.63	49.30	0.68	11.77	8.90
K 1114 x K 0607	42.47	39.56	1.51	2.60	34.43	0.71	10.27	6.65
K 1114 x K 0424	55.46	42.65	1.81	2.80	35.27	0.60	12.43	15.78
K 1114 x K 0 911	47.31	40.33	1.81	2.67	43.40	0.73	13.83	13.59
K 1114 x K 0307	42.26	44.06	1.68	3.87	48.07	0.58	13.23	10.05
K 1114 x NW 2036	51.58	45.90	1.72	3.37	41.37	0.68	13.63	15.53
K 1114 x K 9423	32.83	40.26	1.62	3.87	43.60	0.75	13.60	6.47
DBW 14 x K 0607	49.90	39.12	1.73	3.33	47.17	0.76	14.03	12.29
DBW 14 x K 0424	53.57	44.40	1.88	1.63	49.17	0.75	14.43	17.04
DBW 14 x K 0911	37.29	42.40	1.80	2.43	40.63	0.75	13.67	7.84
DBW 14 x K 0307	47.25	37.67	1.66	2.77	43.33	0.76	11.93	10.49
DBW 14 x NW 2036	46.76	42.87	1.93	3.07	54.13	0.75	13.77	9.02
DBW 14 x K 9423	56.74	38.63	1.74	3.70	52.87	0.72	14.40	11.96
K 0607 x K 0424	45.51	41.48	1.69	2.93	49.53	0.75	13.23	10.76
K 0607 x K 0911	46.64	44.92	1.73	2.70	42.60	0.76	15.06	14.11
K 0607 x K 0307	46.05	44.09	1.61	3.17	42.33	0.71	14.89	13.03
K 0607 x NW 2036	47.95	37.09	1.48	3.53	46.20	0.76	13.47	11.95
K 0607 x K 9423	48.26	40.11	1.65	3.07	41.60	0.76	13.95	10.00
K 0424 x K 0911	38.46	37.80	1.44	2.43	51.30	0.75	14.21	6.46
K 0424 x K 0307	46.26	41.45	1.73	2.53	51.67	0.67	13.94	10.41
K 0424 x NW 2036	47.48	45.40	1.72	2.27	42.97	0.75	13.57	8.45
K 0424 x K 9423	49.77	43.44	1.65	3.40	46.10	0.76	14.56	8.92
K 0911 x K 0307	48.94	44.08	1.78	2.50	42.83	0.69	13.28	14.94
K 0911 x NW 2036	49.56	42.11	1.73	3.03	49.43	0.77	13.63	12.94
K 0911 x K 9423	47.92	40.21	1.59	3.00	39.90	0.67	13.86	11.82
K 0307 x NW 2036	50.75	41.30	1.70	3.60	44.07	0.74	12.38	12.21
K 0307 x K 9423	53.02	45.05	1.73	3.10	43.37	0.75	11.86	14.56
NW 2036 x K 9423	52.97	42.07	1.67	2.63	33.40	0.76	13.41	9.94
K 9533	43.24	39.52	1.70	3.10	46.73	0.718	11.36	8.37
K 9162	51.58	40.64	1.68	3.06	41.40	0.609	12.95	10.11
K 1114	53.03	42.84	1.78	2.96	35.05	0.565	11.25	10.97
DBW 14	43.40	39.44	1.81	3.26	45.20	0.735	10.29	8.25
K 0607	49.25	43.31	1.66	2.90	45.70	0.669	11.83	9.96
K 0424	46.31	38.87	1.54	2.70	44.86	0.776	12.25	7.41
K 0911	52.79	41.07	1.65	4.03	48.33	0.787	11.93	10.08

K 0307	52.55	44.39	1.51	2.43	33.53	0.728	12.55	12.18
NW 2036	43.31	43.05	1.69	2.83	43.30	0.615	11.20	8.07
K 9423	45.05	40.16	1.91	2.63	48.43	0.784	11.44	9.35
Mean	46.95	41.40	1.68	3.14	44.38	0.71	12.46	10.85
C.V.	4.28	1.45	4.69	11.69	3.71	1.44	1.57	5.60
C.D. (5%)	3.25	0.97	0.12	0.59	2.66	0.02	0.31	0.98
C.D. (1%)	4.30	1.29	0.16	0.78	3.53	0.021	0.42	1.30

Table 3: Genetic parameters for 18th quality and quantitative characters in bread wheat

Attributes	σg	σp	Coefficient of variation		h % (b,s)	GA
			PCV	GCV		
Days to 75% flowering	50.52	53.20	9.35	9.11	95	23.45
Days to maturity	92.71	96.49	8.34	8.18	96	21.16
Duration of reproductive phase	18.23	19.22	11.02	10.73	95	27.59
Plant height (cm)	60.38	65.45	9.03	8.67	92	21.98
No. of effective tillers per plant	0.75	0.89	19.39	17.74	84	42.85
No. of spikelets per spike	1.93	2.72	8.34	7.03	71	15.62
No. of grains per spike	38.38	58.85	14.55	11.75	65	25.05
Grain weight per spike (g)	0.12	0.14	17.50	16.26	86	39.88
Spike length (cm)	0.60	0.64	6.78	6.57	94	16.79
Biological yield per plant (g)	17.21	17.77	18.37	18.08	97	46.97
Harvest index (%)	32.13	36.16	12.81	12.07	89	30.04
1000 grain weight (g)	4.82	5.19	5.50	5.30	93	13.50
Spike density	0.01	0.02	7.55	5.91	61	12.20
CTD (⁰ C)	0.54	0.67	26.11	23.35	80	55.10
Chlorophyll intensity (%)	25.90	28.63	12.05	11.47	90	28.80
Chlorophyll fluorescence(Fm/Fv)	0.00	0.00	7.73	7.59	97	19.69
Protein content (%)	1.83	1.87	10.98	10.86	98	28.38
Grain yield per plant (g)	7.44	7.81	25.74	25.13	95	64.75

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